THE EFFECT OF CONTEXT ON RECALL AND RECOGNITION OF LONG VERBAL SERIES

William H. Sumby

JUNE 1966

DECISION SCIENCES LABORATORY
DEPUTY FOR ENGINEERING & TECHNOLOGY
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
United States Air Force
L.G. Hanscom Field, Bedford, Massachusetts

Project 7682
Task 768201

LEGAL NOTICE

When U.S. Government drawings, specifications or other data are used for any purpose other than a definitely related government procurement operation, the government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

OTHER NOTICES

Do not return this copy. Retain or destroy.

ESD-TR-66-278

THE EFFECT OF CONTEXT ON RECALL AND RECOGNITION OF LONG VERBAL SERIES

William H. Sumby

JUNE 1966

DECISION SCIENCES LABORATORY
DEPUTY FOR ENGINEERING & TECHNOLOGY
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
United States Air Force
L.G. Hanscom Field, Bedford, Massachusetts

Project 7682
Task 768201

FOREWORD

This research was performed at the Decision Sciences Laboratory, Electronic Systems Division, Air Force Systems Command, as part of Project 7682, Man-Computer Information Processing, Task 768201, Data Presentation and Human Data Processing.

This Technical Report has been reviewed and is approved.

DONALD W. CONNOLLY
Chief, Display Division
Decision Sciences Laboratory

ROY MORGAN, Colonel, USAF
Director
Decision Sciences Laboratory

ABSTRACT

The effects of context on the recall and recognition of words in that context were investigated under a variety of constraints. The major results are reported below.

1. The recall of a particular word in a sentence when the sentence is presented for a second time with that word omitted is a direct function of the probability of the word occurring within the context, regardless of the word-frequency in the language.

2. Recognition of a particular word in a sentence is not influenced by the probability of the word occurring within the context.

3. In recognition there is a strong response bias to identify a word as having previously occurred when long series of material are shown.

4. In both recall and recognition there is a highly significant relationship between the confidence which is assigned to the response and the correctness of that response.

The results are discussed in terms of retrieval of material from memory as involving a search process.

THE EFFECT OF CONTEXT ON RECALL AND RECOGNITION OF LONG VERBAL SERIES

WILLIAM H. SUMBY

Introduction

Contextual constraint refers to the degree of restriction imposed upon the occurrence of particular symbols, words or letters, in a passage by all of the other symbols in that passage. It is actually the average transitional probability existing between all adjacent and remote symbols within a particular context. It acts as a contextual mnemonic in the prediction of verbal symbols. Miller and Selfridge (1950), Sharp (1958), Tulving and Patkau (1962), and others have demonstrated that the amount of verbal material which can be recalled after a single presentation varies directly with the degree of contextual constraint present in the sequence. In the studies cited the tasks involved the recall of entire passages of words, ordered or free recall, varying in contextual constraint and word-frequency.

It is the purpose of the study reported here to measure the effects of such contextual mnemonics on the recall and recognition of particular words from long series of sentences, and to determine the degree of confidence with which the responses are made. Specifically, the study is concerned with the retrieval of word series of such length that complete series retrieval after but a single presentation is virtually impossible without the aid of some type of mnemonic. The notion is that contextual mnemonics will significantly improve performance, but will affect recall and recognition differently. It is hypothesized that as the probability of a word logically occurring in a particular context is increased, regardless of the frequency of occurrence of that word in the language, the probability of recall will be greater when that word is omitted from the context on a second presentation. This hypothesis

is based mainly on the results of the previously cited Miller and Selfridge study in which they found recall to be a function of the contextual constraint built into word series. It is also expected that the confidence with which a correct response is made will increase directly with probability of occurrence in recall. Furthermore, it is hypothesized that the recognition of words in context will be the same or even slightly higher for low-probability words since the occurrence will be more unusual, probably developing a more vivid perceptual trace. This hypothesis is based on the findings of Miller and Selfridge and others concerned with the influence of contextual constraint, and in addition the findings of von Restorff (1933) demonstrating the effects of atypical material on serial recall. It is also possible that the probability of a word, per se, being recognized in context is not a function at all of the probability of a particular word occurring in the context. It might be that it is the sentence which is recognized, and such sentences may differ little in a priori probability of occurrence, and thereby the effect of the probability of word occurrence would be minimized. It is also expected that more confidence will be indicated in the recognition response than in the recall response, simply because recognition actually only involves a binary choice whereas recall involves, typically, a much more extensive memory search.

Method and Procedure

The manipulation of contextual constraint is typically accomplished by resorting to the use of approximations to English (Shannon, 1948). The present study makes use of another device in which contextual constraint imposed upon a particular word in textual material is manipulated. The present technique also involves an approximate specification of the probability of occurrence of words in a particular context. The technique is quite similar to the "Cloze" procedure developed by Taylor (1956).

The stimulus materials were developed from 120 declarative, 6 word sentences selected from the accumulation of sentences used in a study by Aborn and Rubenstein (1956). The 120 sentences were selected in such a manner that there were 20 sentences having a noun in the first position, 20 sentences having a noun in the second position, and so on. The sentences were then printed on 3 x 5 cards with the noun in the particular position omitted from the text, but the space indicated. The cards were then shown to 100 laboratory personnel and college students who were asked to insert a semantically acceptable noun in the space. The responses were tallied and the probability, based on such responses, of each noun occurring in this context calculated. Such, hereafter, is referred to as the response probability. From this material 2 series of sentences were generated. In the first series the noun included was the noun showing the highest probability of occurrence for each sentence, and in the second series a noun of very low-probability but semantically and logically acceptable was inserted. The average probabilities were .28 for the high and .02 for the low. Word-frequency counts, according to the Thorndike-Lorge L count (1944), were recorded for both series of nouns, and the difference between the means was so small that word-frequency per se can be discounted as contributing to any variance occurring between the groups.

Four experimental groups of 20 Ss each were used. Group 1 was shown only the high-probability series, Group 2 the low-probability series, and Group 3 was shown a series made up of 60 sentences from the high- and 60 from the low-probability series. The retrieval method used by each of these 3 groups was recall. Each sentence was typed with the particular noun printed in capital letters and transferred to Thermofax transparencies for projection onto a large screen. Complete sentences were then shown to the Ss of Groups 1 and 2. Immediately following this presentation the sentences were shown for a second time to Groups 1 and 2, this time with the critical noun omitted from the sentence. The task was to supply the word seen in that space

during the first presentation. For Group 3 the Ss were shown the complete sentences, again with the critical noun capitalized and immediately following such presentation were told simply to recall as many of the capitalized nouns as possible without the aid of the contextual mnemonic.

The Ss of Group 4 were shown a series of 120 sentences, 60 from the high-probability series, and 60 from the low. After they had seen the 120 sentences they were shown a second series of 120 sentences. Of these sentences 60 were exactly the same sentences they had been previously shown, 30 high- and 30 low-probability. In the remaining 60 sentences the noun which had been capitalized was replaced by another noun having approximately the same probability of occurring in this particular context as the noun shown during the initial presentation. The task here was to state whether or not the work was occurring in the context for the first or second time. If the S believed that the critical word was new, she was asked to supply the word seen during the first presentation, if possible.

In all Groups the Ss were tested individually in a quiet room. Each sentence was exposed for 3 seconds with an interval of 1 second between each exposure. Five seconds were allowed for a response in Groups 1, 2, and 4. The total time allowed for recall for Group 3 was 15 minutes.

In addition to the responses described above a confidence rating for each response was requested with the exception of Group 3. Three confidence categories were used: "1", a guess, "3", positive that the response is correct, and "2", a response between the two previous.

The Ss were all students of Regis College for Women and were paid for participating.

Results

With recall as the response mode the differences between the number of correct retrievals for the high-probability Group and both the low-probability and mixed Groups are significant at less than the .01

level, as determined by a Kolmogorov-Smirnov two-sample, two-tailed test[1] (N 20, K_D 20), 76.2 for the high and 32.7 for the low for Groups 1 and 2. The difference between the low-probability Group and the total mixed Group is not statistically significant. Nor is there a significant difference between the low-probability Group and the percent recalled for either the high- or low-probability words of the mixed Group. Apparently retrieval of a low-probability word shown once in a particular context is not significantly enhanced by the context, and further interfers with recall of the high. The difference between the number of high- and low-probability words retrieved for the mixed group, however, was found to be significant at the .01 level (N 20, K_D 13). Total recall for the mixed Group was 30.6 percent, and of these words 62.1 percent were high-probability and 37.9 percent were low.

The percentage of words recalled as a function of the more specific probabilities, i.e., restricted ranges, are presented in Fig. 1. The data points do not represent the actual percent recalled, by a transformed and more conservative figure. The diagonal represents the "ideal" line indicating the probability of supplying the desired word without any previous exposure to the sentence. These points, then, represent the percent recall between such a line and complete recall. More specifically, at point 47 on the abscissa and 77 on the ordinate we find that the distance from the diagonal is 53 percent to complete recall, 100 percent. The actual percent recalled here was 88 which is 41 percent above the line. The rationale was that since 41 percent of the distance from the diagonal to the level of complete recall a more realistic measure of recall would be obtained. It is obvious that, indeed, recall of words seen once in context, and omitted from that context is a positive, non-linear function of the probability of a word occurring in that context.

A gross analysis was made to determine whether or not serial position effects were different for the 3 Groups. Fig. 2 shows these data.

---

1. This statistic was used throughout the data analysis in testing significances of differences.

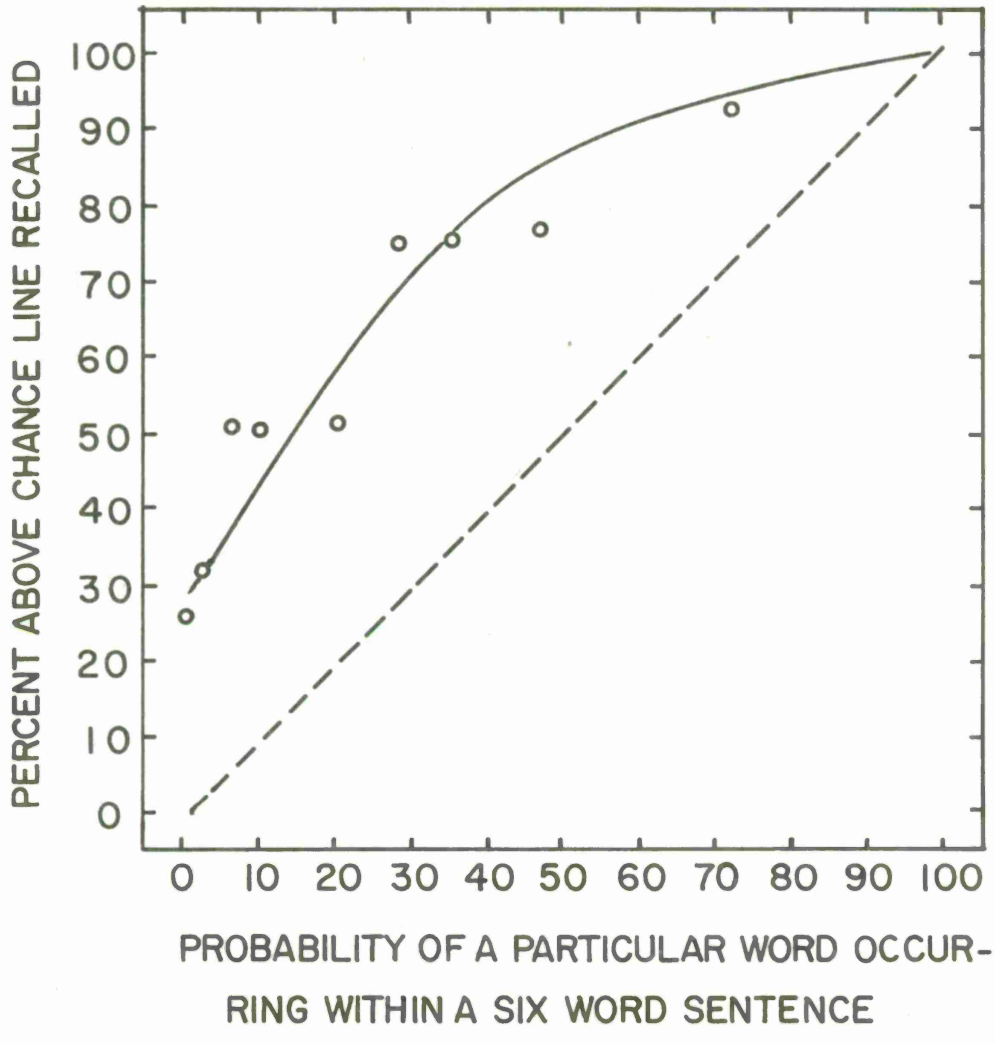

Fig. 1

The percent words above the chance line recalled as a function of the probabilities of the words occurring within the context of a 6 word sentence.

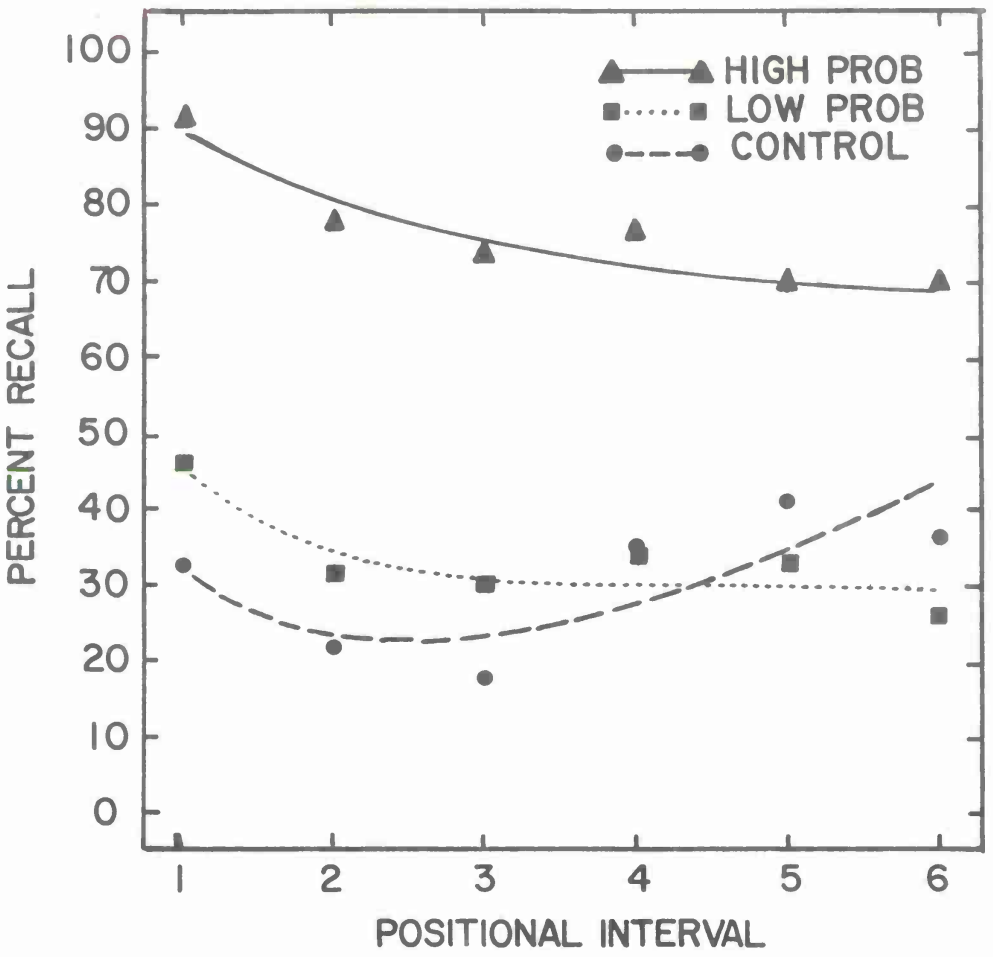

Fig. 2

The gross serial position curves for the 3 recall conditions. Each point has been determined by totaling the number of words correctly recalled for each successive 1/16 of the series.

It is quite apparent that all of the curves are different from one another, with the curve describing recall without the contextual mnemonic most similar to the typical serial position functions when free-recall is the response mode. This was expected in that the Ss in the control Group typically responded first with words near the end of the series. In the other two Groups the response sequence was randomized.

Analysis of the data derived from the rating of responses according to confidence in recall will be considered later with the same type of results with recognition.

Table 1 represents the results when recognition was the response mode, the upper figures represent the number of responses, the lower the

percent. The notations used in the contingency matrices are as follows: 1) S_oR_o--stimulus "old", response "old", 2) S_oR_n--stimulus "old", response "new", 3) S_nR_n--stimulus "new", response "new", and 4) S_nR_o--stimulus "new", response "old".

==========

	High				Low		
	R_o	R_n			R_o	R_n	
S_o	533	67	600	S_o	553	47	600
	44.4	*05.6*	*50.0*		*46.1*	*03.9*	*50.0*
S_n	156	444	600	S_n	127	473	600
	13.0	*37.0*	*50.0*		*10.6*	*39.4*	*50.0*
	689	511	1200		680	520	1200
	57.4	42.6			56.7	43.3	

Combined

	R_o	R_n	
S_o	1086	144	1200
	45.2	*04.8*	*50.0*
S_n	283	917	1200
	11.8	*38.2*	*50.0*
	1369	1031	2400
	57.0	*43.0*	

Table 1

Response Contingency Matrices
for Recognition

It is apparent that correct recognition of either an "old" or a "new" stimulus is extremely high, overall 83.4 percent. Unlike the results with recall there is no significant difference in the amount of correct retrieval between the high-probability words and the low. As a matter of fact, there is a slight difference, but insignificant, in favor of the low-probability words, 81.4 percent for the high and 85.5 for the low.

There is evidence of a rather strong response bias in favor of an "old" response shown in each of the matrices of Table 1. The differences between the number of "old" and "new" responses made were significant at less than the .01 level in each case (N 20, Total K_D 12, High 14, and Low 12). This response bias is maintained throughout the series. None of the differences between each 1/6th of the series, i.e., 1 -20, etc., proved to be statistically significant.

Another, probably more revealing, measure of the response bias is by estimations of the contingent probabilities. Even though the "old" stimuli were correctly called "old" more often than "new", if a response of "new" was made the probability of that response being correct was greater than the probability of an "old" response being correct.

In addition to making a response of "old" or "new", the Ss were asked to supply the word shown in the first presentation, if possible, when a response of "new" was made. In this case the difference in recall of high- and low-probability words again becomes apparent. The high-probability words were recalled in 45.8 percent of the cases when a response of "new" was made, and 26.7 percent for low. This difference is statistically significant at less than the .01 level (N 20, K_D 19).

Fig. 3 shows the percent correct retrieval as a function of the confidence rating assigned to the response. Fig. 3A presents the data summary for recall, and 3B for recognition for both high- and low-probability words. It is apparent that the relationship between confidence and correctness is highly significant. Different response biases were noted for the two recall groups. In both groups the use of the intermediate confidence rating was very low. However, with the high-probability group the bias was in favor of a positive rating and with the low the rating indicating a guess.

It can be seen in the figure summarizing the recognition data that the functions very closely approximate the "ideal", the dotted line. The

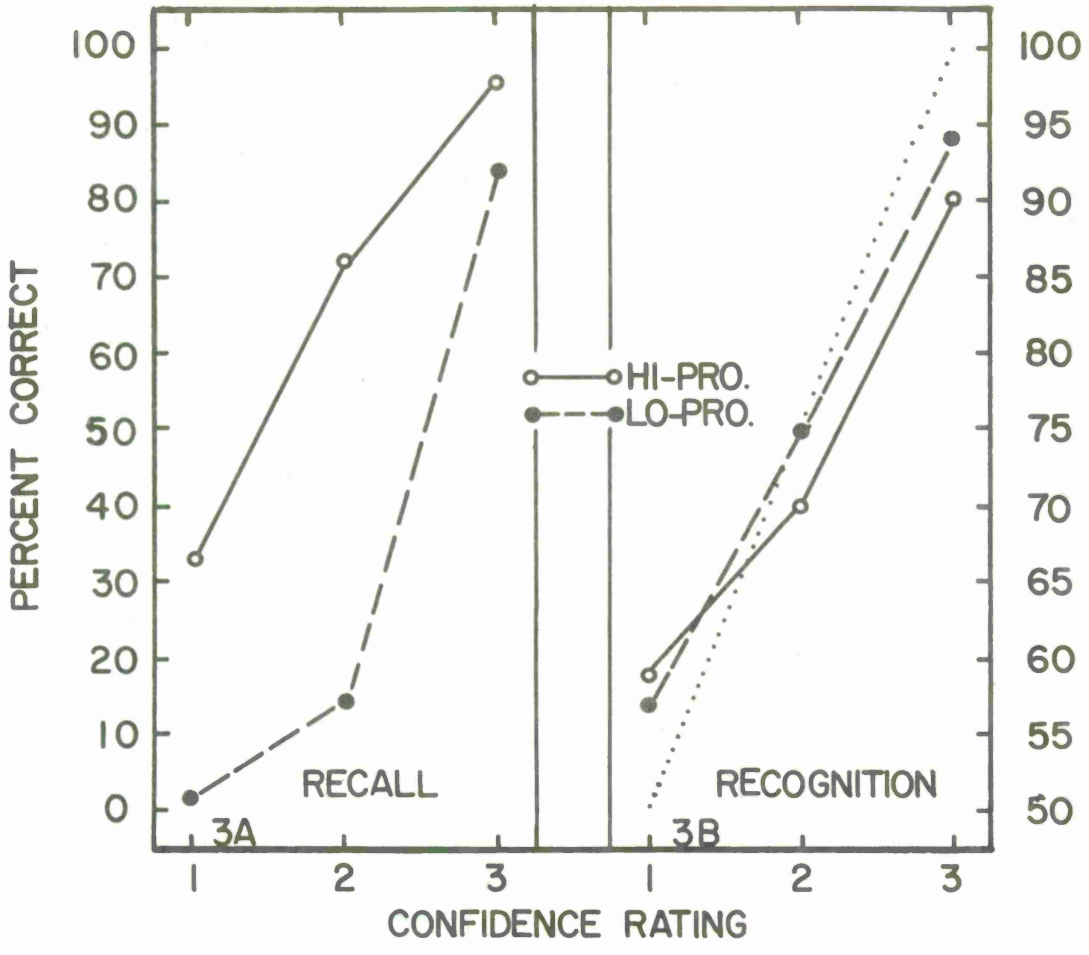

Fig. 3

The percent correct retrieval as a function of the confidence rating assigned to the response. 3A presents the data for recall, and 3B recognition.

"ideal" line was drawn since in this particular recognition situation the response only involves a binary decision. A confidence rating of "1" yields a response very close to chance and a rating of "3" yields a response very close to perfection for both the high and low contexts. It must be admitted, however, that such a line is somewhat questionable since it is based on the assumption of a linear scale of confidence ratings for recognition.

Table 2 presents a breakdown of the recognition response as a function of confidence rating given to the responses. The notations are the same as those in Table 1. The upper figure represents the actual frequency of occurrence of the response for the particular cell.

Rating		Hi-Pro R_o	Hi-Pro R_n		Lo-Pro R_o	Lo-Pro R_n	
Positive (3)	S_o	415 *55.7*	20 *02.7*	435 *58.4*	466 *59.3*	9 *01.1*	475 *60.4*
	S_n	47 *06.3*	263 *35.3*	310 *41.6*	37 *04.7*	274 *34.9*	311 *39.6*
		462 *62.0*	283 *38.0*	745	503 *64.0*	283 *36.0*	786
Intermediate (2)	S_o	91 *29.5*	22 *07.1*	113 *36.7*	72 *25.0*	22 *07.6*	94 *32.6*
	S_n	71 *23.1*	124 *40.3*	195 *63.3*	51 *17.7*	143 *49.7*	194 *67.4*
		162 *52.6*	146 *47.4*	308	123 *42.7*	165 *57.3*	288
Guess (1)	S_o	27 *18.4*	25 *17.0*	52 *35.4*	15 *11.9*	16 *12.7*	31 *24.6*
	S_n	38 *25.8*	57 *38.8*	95 *64.6*	39 *31.0*	56 *44.4*	95 *75.4*
		65 *44.2*	82 *55.8*	147	54 *42.9*	72 *57.1*	126

Table 2

Response Contingency Matrices for Recognition as a Function of Confidence Ratings

The lower, italicized, figure is simply the frequencies converted to percents. It can be noted that at high levels of confidence, "3" there is a greater frequency of "old" responses than "new", and the percent of responses called "old" correctly was greater for both probability levels than the percent of responses called "new". As the level of confidence decreases there is a tendency for Ss to respond "new" with a greater frequency than "old", and the percent of responses correctly called "new" is greater than the percent of correct "old" responses.

Discussion

It was hypothesized that as the probability of a word logically occurring in a particular context is increased, regardless of the frequency of occurrence of that word in the language, if that word is omitted from the context on a second presentation the probability of retrieval will be greater. The data support this hypothesis. It was revealed that the number of words recalled increases significantly as the probability of a word occurring in a particular context is increased. It was further hypothesized that the recognition of words in context will be the same or better for low-probability words than high since the occurrence will tend to be novel resulting in a more striking perception. The data support this hypothesis; recognition was about the same for both conditions. As a matter of fact, words out of context appear to be recognized at about the same level as in context, overall 78.4 percent (Sumby, 1965). This mean and the contextual overall mean were not significantly different. Such a finding would indicate that it is the word that is recognized, rather than as suggested in the introduction, that it is the sentence which is recognized.

There are really no reasons to assume that the storage processes used for the two experimental situations are different even though the Ss were aware of the nature of the retrieval task. Likewise, there are no reasons to assume that the retrieval processes are different, although because of the apparent difference in difficulty between the two modes of retrieval one might easily conclude that there is. It is suggested, as did Yntema and Trask (1963), that retrieval involves a

search through memory storage. It is further suggested with the type of material used in this study, recall involves a search through a much larger sample-space than does recognition. With recall more is involved than binary choices, it involves a complex symbol search through storage before a decision is made. It is believed that this notion would account, too, for the difference between the number of words recalled for the high- and low-probability words. In this experimental situation the context acts as a mnemonic. If the probability of the omitted word occurring in a particular context is high the sample-space is considerably reduced and the number of alternatives which must be inspected is likewise increased. It is concluded, therefore, that the difference found between the two experimental conditions in recall can be attributed to a difference in the number of possible alternatives to be inspected.

Recognition, on the other hand, might be compared to an identification task. Did this event occur previously? It involves only a binary choice, or quite possibly a series of such choices. As with recall, the number of binary choices which must be made with the high-probability material is quite low, and therefore the number of words correctly recognized as "new" or "old" is high. With low-probability words, on the other hand, it might be assumed that the number of choices which must be made is high. It is suggested, however, that this is not really the case. It appears that a phenomenon somewhat similar to the von Restorff effect occurs. That is, an unusual event takes place which creates a vivid perceptual trace of the entire context. If the context is presented for a second time the S can quite easily identify the word as having occurred or not occurred on the previous presentation. However, if a "new" word replaces the word seen previously, that, too, is an unusual event and appears to mask the first, but is recognized as being "new". Evidence in support of such a statement is that the Ss were asked to give the word shown in the first presentation if possible, when the word on the second presentation was identified as "new". The number of low-probability words recalled in such a situation was found to be significantly lower than the number of high-probability words recalled.

Summary

The effects of context on the recall and recognition of words in that context were investigated under a variety of constraints. The major results are reported below.

1. The recall of a particular word in a sentence when the sentence is presented for a second time with that word omitted is a direct function of the probability of the word occurring within the context, regardless of the word-frequency in the language.
2. Recognition of a particular word in a sentence is not influenced by the probability of the word occurring within the context.
3. In recognition there is a strong response bias to identify a word as having previously occurred when long series of material are shown.
4. In both recall and recognition there is a highly significant relationship between the confidence which is assigned to the response and the correctness of that response.

The results are discussed in terms of retrieval of material from memory as involving a search process.

References

Aborn, M., and Rubenstein, H. Word-class distribution in sentences of fixed length. Language, 1956, 32, 666-674.

Miller, G. A., and Selfridge, J. A. Verbal context and the recall of meaningful material. Amer. J. Psychol., 1950, 63, 176-185

Restorff, H.v. Uber die Wirkung von Bereichbildung im Spurenfeld. Psychol. Forsch., 1933, 18, 299-324.

Shannon, C.E. A mathematical theory of communication. Bell Syst. Tech. J., 1948, 27, 379-423.

Sharp, H. C. Effect of contextual constraint upon recall of verbal passages. Amer. J. Psychol., 1958, 71, 568-572.

Sumby, W. H. Incremental or one-trial learning of verbal series. ESD-TR-64-555, 1965, AD 623 383.

Taylor, W. L. Recent developments in the use of "Cloze Procedure". Quart. J. Psychol., 1956, 33, 98

Tulving, E. B. and Patkau, J. E. Concurrent effects of contextual constraint and word-frequency on immediate recall and learning of verbal material. Canad. J. Psychol.,

Yntema, D. B., and Trask, F. P. Recall as a search process. J. verb. Learn. verb. Behav., 1963, 2, 65-74.

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)	2a. REPORT SECURITY CLASSIFICATION
Decision Sciences Laboratory, Deputy for Engineering and Technology, L. G. Hanscom Field, Bedford, Mass.	Unclassified
	2b. GROUP N/A

3. REPORT TITLE

THE EFFECT OF CONTEXT ON RECALL AND RECOGNITION OF LONG VERBAL SERIES

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

None

5. AUTHOR(S) (Last name, first name, initial)

Sumby, William H.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
June 1966	18	9

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
IN-HOUSE	ESD-TR-66-278
b. PROJECT NO.	
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	

10. AVAILABILITY/LIMITATION NOTICES

Distribution of this document is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
None	Decision Sciences Laboratory, Deputy for Engineering & Technology, Electronic Systems Division, AFSC, USAF, L. G. Hanscom Field

13. ABSTRACT

The effects of context on the recall and recognition of words in that context were investigated under a variety of constraints. The major results are reported below.

1. The recall of a particular word in a sentence when the sentence is presented for a second time with that word omitted is a direct function of the probability of the word occurring within the context, regardless of the word-frequency in the language.

2. Recognition of a particular word in a sentence is not influenced by the probability of the word occurring within the context.

3. In recognition there is a strong response bias to identify a word as having previously occurred when long series of material are shown.

4. In both recall and recognition there is a highly significant relationship between the confidence which is assigned to the response and the correctness of that response.

The results are discussed in terms of retrieval of material from memory as involving a search process.

DD FORM 1 JAN 64 1473

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Contextual Constraint						
Probability of Occurrence						
Response Probability						
Recall						
Recognition						

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2*a*. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2*b*. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7*a*. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7*b*. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8*a*. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8*b*, 8*c*, & 8*d*. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9*a*. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9*b*. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through _____."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through _____."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through _____."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS)*, *(S)*, *(C)*, or *(U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional

Printed by
United States Air Force
L. G. Hanscom Field
Bedford, Massachusetts